The Science and Art Museum Dublin is issuing a series of 'guides' to the collections, which are sold at the nominal price of a penny. The last two of the series, devoted to armor, and to arms (European) are by M. S. D. Westropp and comprise a descriptive catalogue of the specimens in the museum, with a large amount of general information as to the classes of objects described. They are extremely interesting and models of their kind.

SOCIETIES AND ACADEMIES

THE GEOLOGICAL SOCIETY OF WASHINGTON

At the 187th meeting of the society, on February 13, 1907, Mr. J. S. Diller presented briefly the results of extended studies by him on the age of the auriferous gravels in Oregon and the discovery of marine Eocene fossils in the same.

Mr. Fred. E. Wright exhibited artificial crystals of cuprite and an asbestos-like mineral of the composition of tremolite, both formed at high temperatures and under considerable pressure.

Regular Program

Mr. Whitman Cross gave a brief review of the recent article on 'New Textual Terms for Igneous Rocks' by Cross, Iddings, Pirsson and Washington in the *Journal of Geology*, XIV., 692–707, and emphasized the underlying principles which guided the authors in their classification and description of the textures of igneous rocks.

The Pine Mountain Fault: Mr. R. W. Stone.

Pine Mountain forms part of the boundary between Kentucky and Virginia and is a long narrow ridge having a general elevation of 3,000 feet. This discussion deals only with the northern end of the mountain from Pound Gap to Big Sandy River. The Virginia side of the mountain is comparatively steep, the strata dipping southeast at angles up to 25 degrees, while the north or Kentucky side is precipitous and a good example of a fault scarp. The great fault which formed the mountain is on the north side and parallels the crest of the ridge for many miles. In the 'breaks' where Russell Fork of Big Sandy River passes the end of the mountain in a gorge 1,000 feet deep, a diagrammatic section shows clearly the uplifting and over-riding of the Lee conglomerate on the upturned edges of the Coal Measures. In the coal field immediately west of the Pine Mountain the Lower Elkhorn seam commonly shows a fifteen-inch bench of laminated coal. It has every appearance of squeezing and movement, the coal being crushed to a flaky condition and the surfaces of the flakes slickensided. The lamination may be parallel to the bedding, but is often tilted or contorted; it decreases and disappears at a distance of several miles from the mountain.

Phosphate Deposits in the Western United States: Mr. F. B. Weeks and Mr. W. F. Ferrier.

It has been found during the past few years that the limestone strata of the upper Carboniferous of the Central Cordilleran region include a series of oolitic beds containing a variable percentage of P_2O_5 and varying in thickness from a mere trace to ninety feet. These beds are known to occur in Idaho, Wyoming, Utah and Nevada, and future exploration may show that they have a still wider distribution. They are usually underlain by blue-gray compact limestone strata which in turn pass into sandy limestones and yellow sandstones. The phosphate series consists of alternating layers of black phosphatic material, shale and hard blue or brown compact limestone which is often fossiliferous with *Rhynchonella, Chonetes* and *Euomphalatrochus* as characteristic forms. Within the series the phosphate beds vary in thickness from a few inches to ten feet, some of which are almost entirely oolitic in character and commercially valuable because of their high content of P_2O_5, the average analysis of carload lots giving 32 per cent. P_2O_5 equivalent to 70 per cent. bone phosphate.

In Utah the phosphate series is exposed in Weber Canyon near Croydon and also near Woodruff; in Wyoming, near Sage and also near Cokeville, where it extends along the west face of the Sublette Range on the east side of the valley of Thomas Fork; on the east side of Bear Lane and along the west

face of the Preuss Range in Idaho, at Montpelier, Bennington, Georgetown and in the vicinity of Swan Lakes. This discovery has opened a new industry in the west; its future development is dependent on the cost of transportation to foreign and domestic markets.

The 188th meeting of the society was held on February 27 and was devoted to a consideration of the 'Methods of Igneous Intrusion.'

The discussion was opened by Mr. Whitman Cross, who directed it to the methods by which the large igneous masses, such as laccoliths, stocks and batholiths, have come to the places where they are now visible. The three main agencies called upon in current literature to account for these masses are: (1) Mechanical displacement of the invaded rocks, (2) fusion and assimilation of the rock by the magma, (3) 'magmatic stoping.'

It was claimed that laccoliths, in the sense of Gilbert's original definition, and many closely allied bodies, are beyond question produced by a purely mechanical uplift of rocks, usually sedimentary, above the plane of intrusion; that assimilation and stoping are at the most rare and subsidiary phenomena. No instances are known to the speaker.

The origin of stocks and batholiths, viewed as very similar except in point of size, is less evident than that of laccoliths, because we can ascertain the relations for only a portion of each mass. That fusion of country rock by an invading magma, with subsequent assimilation, is a demonstrated or adequate explanation for stocks and batholiths was denied. This hypothesis is usually advanced with naïve disregard for the difficulties involved in its acceptance. Among these were mentioned: (1) The manifest impossibility of assimilating and assimilated rocks occupying the same space: (2) the physical problem of supplying and maintaining the heat necessary to keep the magma liquid in spite of conduction into wall rock and absorption in the fusion assumed; and (3) the necessity for demonstrating that an invading magma, as, for instance, one of granitic composition, had been changed in character through assimilation of quartzite, limestone, or basic igneous rocks. In most stocks and batholiths there is absolutely no evidence that fusion of wall rock has occurred. It can scarcely have taken place on a large scale without leaving evidence of such action. While fusion must surely be assumed as taking place under certain conditions, there is no good reason to believe that those conditions were realized in known stocks and batholiths. Even should extensive fusion be demonstrated for certain cases, that process is not in itself competent to explain the masses under discussion.

Mr. Cross called special attention to the hypothesis of 'magmatic stoping' advocated forcibly by Daly in the last few years. After assuming that crustal movements must result in liquefaction of rock locally through decrease of pressure, the magma is pictured by Daly as eating its way upward by a process in which the main factors are the detachment of blocks of rock from the cover of the molten mass, their descent into the lower and hotter parts of the magma and consequent fusion and absorption. It is supposed that the magma may thus quietly rise far into the crust to horizons which through erosion have in many cases become accessible to our observation.

The magmatic stoping hypothesis of Daly rests upon two fundamental assumptions—viz., that the magmas of stocks and batholiths possess a high degree of liquidity and that the specific gravity of most crystalline rocks is greater than that of even a gabbroic magma in the assumed liquid condition. The high liquidity of batholithic magmas, although assumed by Daly as a matter of common acceptance, was questioned by the speaker on the basis of recent physical investigations and observed facts. In general, the facts of field occurrence are believed to show that the magmas of batholiths have in reality a high sustaining and lifting power; that blocks of country rock do not sink, but rather float, in the magmas; that basic inclusions, often of considerable size, are brought up from the depths in batholithic magmas. The data at our disposal for estimating differences in density between magmas and solid rocks are

meager and inconclusive. In any case, the hypothesis fails to account for basic stocks in highly siliceous rocks.

Referring to stocks and batholiths which he had studied, Mr. Cross stated that they testified rather to violent and powerful ascensive forces back of the magmas and expressed the belief that in such masses, as in laccoliths, the coming to place of the magmas was in first degree a mechanical displacement of the invaded rock, as such.

Mr. G. F. Becker considered the intrusive magmas from a physical and chemical standpoint and emphasized his view that such magmas are emulsions rather than liquids; that, at the time of intrusion, they consist largely of crystal aggregates with a small amount of interstitial material not yet crystallized—a fact evident from the mutual interference and simultaneous crystallization of the components of any deep-seated rock. This state was compared to that of partially melted snow which consists of ice crystals with some free water; in short, the magma at the time of intrusion is a soft solid like modeling clay and the intrusion must therefore follow different laws from those of an intrusive fluid. In particular he pointed out that semi-solid magmas may support masses of relatively large density. The presence of aplites and pegmatites in granular intrusives and not in porphyries is significant in support of this theory of the soft solid condition of deep-seated intrusive magmas.

Mr. A. L. Day directed attention particularly to the physical conditions which must be reckoned with in formulating the stoping hypothesis.

1. The wall rocks in these cases must be accounted very good conductors of heat. It is, therefore, difficult to conceive of a sharp temperature difference between the intruding mass and the wall rock existing for more than a very short interval of time, whatever the relative masses involved. If the amount of heat to be distributed is large, active resorption must occur; if small, adjacent layers of the intruding mass will very soon become solid or hyperviscous.

2. The evidence which has been gathered by the Geophysical Laboratory points persistently to the extreme viscosity of all the highly siliceous minerals and mixtures, even at temperatures far above their melting points.

3. There is a very reasonable probability that most crystalline rocks are more dense at the melting temperatures than the liquids which they form, but it will be remembered that Professor Barus's experimental proof was confined to the gradual transition from liquid to amorphous glass, and therefore leaves the important question still open.

Mr. Andrew C. Lawson criticized Daly's hypothesis from the point of view of the great diameter of certain batholiths and the flatness of the arch roofing them. With a span of 100 miles or more, if the roof were specifically heavier than the invading magma, he did not see what would prevent its complete foundering. Referring to the high viscosity of the feldspars and quartz, as determined by Dr. Day's experiments, he indicated that, while this was a property of the individual crystals, it did not finally prove that mixtures of such materials in magmatic fusion with other constituents of granite would be so highly viscous. Dr. Becker had drawn the conclusion that porphyritic structures could only be developed in fluids of high molecular mobility. Now the granite rocks of the High Sierra were highly porphyritic over a wide extent. The large well-formed crystals of orthoclase, commonly over an inch in length, showed that in that great batholith the magma had not been highly viscous. Moreover, these porphyritic orthoclases were chiefly aggregated in the upper levels of the batholith as if they had been assembled there by flotation from the lower levels, again indicating absence of high viscosity. Further, the granite of the Sierran batholith swarms with angular inclusions. These are not fragments that had been torn from the roof and caught in process of sinking. They are mineralogically allied to the lamprophyres, and represent fragments derived from the shattering of deep-seated masses ascending with the upwelling of the batholithic magma. These facts all indicate fluidity. The speaker had, however, been one of the first to argue for the high viscosity of

granitic magmas in the *final* stages of their consolidation, such viscosity ensuing after the crystallization of the feldspars and due to the behavior of the residual free silica of the magma which crystallized as quartz. It was well known that while rhyolitic magmas were more viscous than basaltic lavas, they were nevertheless fluid enough to flow as expansive sheets; and many granitic batholiths approximated such rhyolites in their composition sufficiently to indicate that they were not, except in the final stages of solidification, so highly viscous as to be regarded as solids rather than fluids. The speaker was glad to hear Dr. Day minimize the influence of pressure. He recalled the case of vertical basic dykes which in horizontal section graded from very dense compact porphyritic rocks on their margins to coarse gabbroic rocks in their middle part, 50 feet or less distant. This gradation in structure and texture necessarily occurred under the same pressure, and proved that pressure exercised but little control upon the development of these features.

Mr. G. O. Smith cited observations on intrusion phenomena in Washington, Utah and Massachusetts. In the Tintic Mountains the intrusive monzonite includes angular fragments of quartzite and limestone which have been carried upward after detachment from the wall rock, showing absence of assimilation by the magma and of sinking of the fragments in the same.

Mr. F. E. Wright described briefly examples of batholithic intrusion of granites in southeast Alaska, and of local recrystallization and assimilation of invaded rocks, and emphasized the important rôle of magmatic solutions in producing such alterations, rather than direct melting and absorption by the magma and recrystallization of the whole on cooling.

Mr. Waldemar Lindgren cited a number of examples of intrusions of granitic and dioritic rocks in the Sierra Nevada from which it was clearly apparent that a very considerable pressure was exerted by the intruding magma on the surrounding, steeply dipping slates. In many cases the intrusive rocks cut across the slates in jagged and irregular lines, but in nearly all cases the lateral pressure, resulting in the bending of the slates, is extremely well marked. Practically no evidence of assimilation on a large scale in this region was obtained.

FRED. E. WRIGHT,
Secretary

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 631st meeting was held on March 16, 1907. Dr. L. A. Bauer read a paper on "The Relation between 'Potential Temperature' and 'Entropy.'"

The purpose of this paper was to show the precise relationship between von Helmholtz's term 'waermegehalt' used incidentally by him in connection with his investigations 'On Atmospheric Motions' or of the alternative term 'potential temperature' suggested and used by von Bezold in his papers 'On Thermodynamics of the Atmosphere,' and entropy. It was found that a simple relation existed so that for certain thermodynamic problems the second law of thermodynamics, or the principle of the increase of entropy, could be easily and directly expressed in terms of potential temperature. For these cases whenever the entropy increased during the carrying out of a thermodynamic process, the potential temperature was likewise accompanied by an increase. This was shown by application to certain well-known typical cases of natural, or irreversible processes, *e. g.*, free expansion of gases and heat conduction.

The second paper of the evening was presented by Mr. W. W. Coblentz, upon 'Selective Reflection of Minerals and Lunar Constitution.'

Throughout the spectrum from the ultraviolet into the remote infra-red, various substances show bands of selective absorption and selective reflection. Experiments made to determine whether these bands are due to chemical composition, to molecular weight or to the arrangement of the atoms in the molecule, have always given more or less contradictory evidence; and especially as to the effect of molecular weight. Only recently had the speaker been able to account for most of the contradictions.

From various considerations one would expect to find the bands to shift to the long wave-lengths with increase in molecular weight. It was known that certain groups of atoms cause certain absorption bands, but no shift in the maximum of the band could be detected when the number of groups of atoms was increased in the molecule. The contradiction lies in the failure to make a distinction between the effect of the groups of atoms which is to *cause* the absorption and the reflection bands, and the effect of joining these groups of atoms to various elements (different atomic weight) which have now been found to determine the *position* of the bands. By studying the transmission and reflection spectra of a homologous series of compounds it was found that the position of the characteristic band shifts toward the long wave-lengths, with increase in the molecular weight of the metallic element to which the group of atoms is united to form the compound. These bands lie in the region of $4.5\,\mu$ and $6.5\,\mu$ (transmission) and $8.7\,\mu$ to $9.1\,\mu$ (reflection).

The silicates are exceptions to all the rules, for there seems to be no regularity in the reflection bands, indicating that the grouping of the atoms of oxygen and of silicon is different in the different minerals studied.

When energy is reflected from a plane smooth surface it is commonly called 'regular' (or less accurately 'specular') reflection, while energy reflected from a rough surface suffers 'diffuse' reflection. The reflecting power, R, of any substance is related to its index of refraction, n, and its absorption coefficient, k, by the equation:

$$R = \frac{(n-1)^2 + k^2}{(n+1)^2 + k^2}.$$

For 'transparent media' or 'insulators' the absorption coefficient is almost zero and the reflection power is a function of only the refractive index. Here the reflecting power is low, only 4 to 6 per cent., and decreases with increase in wave-length. For metals, 'electrical conductors,' the absorption coefficient has become so large that nearly all the energy, for all wave-lengths, is reflected (90 to 98 per cent.).

For substances having selective absorption, when the coefficient of absorption, k, attains the high values the heat or light waves no longer enter the substance, but are almost totally reflected as in the case of metals—whence the name, 'bands of metallic reflection.' If, then, the eye were sensitive to heat waves, many substances would have a 'surface color' similar to that of gold and fuchsine in the visible spectrum. Furthermore, substances having selective absorption (and reflection) will have a low reflecting power in the region where the absorption coefficient, k, is small. In other words, the reflecting power of plane surfaces ('regular reflection') of substances ('transparent media,' 'electrical insulators') having selective absorption, will be low for all regions except where there are bands of 'metallic reflection.' It is evident that a rough surface of the same material will behave similarly, *i. e.*, it will likewise be selectively reflecting.

The speaker found that the silicates have a low reflecting power, 'practically zero,' for the region of the spectrum up to $8\,\mu$ followed by bands of metallic reflection from $8.5\,\mu$ to $10\,\mu$.

It was pointed out from the curves exhibited that a surface such as the earth or the moon if composed of silicates will have bands of strong selective reflection. If, then, one were to examine the heat spectrum of a planet which shines by reflected light, and if its surface is composed of silicates, one would expect to find bands due to selective reflection. By comparing these bands with those of known substances, the composition might be determined. In the case of the moon this is practically impossible on account of the weakness of the radiation to be measured. Atmospheric absorption, and the fact that, in the case of the moon, the maximum of its proper radiation lies in the region of the reflection bands of the silicates, will interfere with the observations. But there is still another complication in that the lunar radiation curve can not be smooth and continuous (as some writers seem to think) if the surface is composed of silicates, because in the regions of selective reflection the emitted energy will be

suppressed, *i. e.*, there will be emission minima where there are reflection maxima (Aschkinass, Rosenthal). But the radiation from the moon can not be detected except when it is illuminated by the sun. The result is that if the surface is composed of silicates, then the observed energy curve will be the composite of the selectively emitted energy of the moon, and the selectively reflected energy of the sun. The selectively reflected energy of the sun will to a certain extent fill up the minima in the lunar emission curve. Atmospheric absorption will decrease the intensity of the radiation, so that it is almost too much to hope to study the composition of the various parts of the lunar surface by the identification of the selective reflection bands in its energy spectrum.

R. L. Faris,
Secretary

CLEMSON COLLEGE SCIENCE CLUB

The regular meeting of the club was held on the evening of January 18, at which time Dr. F. H. H. Calhoun gave an illustrated lecture on 'Geological Changes as Factors in Life Development.' The varying relations between the extent of the land masses and the sea was a powerful factor in the life development. When land rose, restricting the habitat of the life of the sea, the weaker ones were compelled to adapt themselves to a different environment or to perish. Again when there was a sinking of the land, the faunæ of the continents were forced to find some avenue of escape for themselves. The various problems which the succession of changes caused were considered in turn, but the main portion of the address was devoted to the development of the vertebrates, especially that of the reptilian dynasty. It seemed less a coincidence that a great geological change was always accompanied by a variation in the flora and faunæ, than that they held the relation of cause and effect.

S. B. Earle,
Secretary

THE ELISHA MITCHELL SCIENTIFIC SOCIETY OF THE UNIVERSITY OF NORTH CAROLINA

The 171st meeting was held in the main lecture room of Chemistry Hall, Tuesday, March 19, 7:30 p.m., with the following program:

Professor J. E. Latta: 'New Developments in Electric Traction.'

Mr. N. C. Curtis: 'Architectural Composition.'

Alvin S. Wheeler,
Recording Secretary

THE ST. LOUIS CHEMICAL SOCIETY

At the meeting of the St. Louis Chemical Society, on March 11, the president, Dr. H. A. Hunicke, opened the proceedings with a brief but feeling encomium on the illustrious chemists, lately passed away in such close succession—Beilstein, Mendeléef, Menchutkin, Roozeboom, Moissan. The society honored the memory of the great ones by rising. Mr. J. J. Kessler presented a paper entitled 'The Chemistry of Electrical Engineering.' Mr. Carl Hambuechen then presented a paper on the cognate subject 'Electro-Chemistry in the Industries.' The latter paper was profusely illustrated with lantern slides.

C. J. Borgmeyer,
Corresponding Secretary

DISCUSSION AND CORRESPONDENCE

THE FIRST REVISER AND ELIMINATION

If the present discussion of the rules and regulations governing zoological nomenclature shall result in a greater degree of uniformity among the workers in this field, the space that has been devoted to the subject in the pages of Science will not have been wasted. Few things have resulted so injuriously to the best interests of natural history as the lack of uniformity in regard to the names employed by different writers, following the radical difference in their methods of procedure.

Even at the present time, however, it appears that certain writers in our midst have not a clear idea of the method of elimination as applied to the settling of the question of the true type species of the earlier genera, apparently laboring under the mistaken impression that it is distinct from, or even opposed to, the first reviser method. As a matter of fact, *it is an integral part of this method.* Thus, the author who first elim-